Verbal Memory Span and Performance Memory Span in Short-term Memory of Mentally Retarded Children

VERBAL MEMORY SPAN AND PERFORMANCE MEMORY SPAN IN SHORT-TERM MEMORY OF MENTALLY RETARDED CHILDREN

By

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The present experiment was designed to assess the validity of the following hypotheses: verbal memory span (VMS) and performance memory span (PMS) in short-term memory (STM) of the retardates in the IQ–50 group are inferior to those in the IQ–70 group, and among the three groups, IQ–50, IQ–60 and IQ–70, there are correlations in VMS and PMS.

The Ss were 83 children, comprising 27 children in the IQ–50 group, 25 in the IQ–60 group, 31 in the IQ–70 group. Testing materials were numerals, common things and building brocks.

The results obtained supported the validity of the hypotheses.

Memory has two categories of short-term memory (STM) and long-term memory (LTM)[1]. Ellis (1963) proposed a stimulus trace theory (S_t theory) concerned especially with STM of the mentally retarded. The key hypothesis of his theory may be summarized: the duration and amplitude of stimulus trace (S_t) are reduced in the subnormal organism, i.e., the organism with lower central nervous system integrity (n_i). Ellis attempted to sustain the validity of this theory, in the light of serial verbal learning, delayed responce, EEG, fixed interval operant conditioning, reaction time and factor analysis. Following his work the literature relating to the S_t theory is rapidly increasing (Baumeister & Ellis, 1963; Baumeister, Spain & Ellis, 1963; Baumeister, Bartlett & Hawkins, 1963; Blue, 1963; Baumeister, Beedle & Urquhart, 1964; Hawkins & Baumeister, 1965; Baumeister, Smith & Rose, 1965; Lance, 1965; Borokowski, 1965; Lobb & Nugent, 1966; Hawkins, 1966; Spraque and Quay, 1966). Ellis's S_t theory follows the view that, with regard to tasks which require the utilization of STM, mentally retarded children can achieve only the tasks which are at a lower level than those which normals can take. Here arises a question as to whether or not the low IQ group of so-called educable mentally retarded children similarly can accomplish only the STM tasks that are at a lower level than those which the high IQ group can take.

[1]In the present paper the terms "short-term memory" and "long-term memory" are used in the same way as defined by Ellis (1963); short-term memory is measured in soconds or minutes as contrasted with long-term memory measured by hours, days, or even years.

The present study deals with the verbal memory span (VMS) and the performance memory span (PMS)[2] in STM of mentally retarded children, placing greater emphasis on the IQ and testing material dependence of VMS and PMS.

Experiment I

Attempts were made to prove the validity of the following hypotheses:

Hypothesis I: VMS testing material; numbers and PMS testing material; specific objects in STM of the retardates in the IQ–50 group are inferior to those in the IQ–70 group.

Hypothesis II: Among the three groups of IQ–50, IQ–60 and IQ–70, there are correlations in VMS (testing material; numbers) and PMS (testing material; specific objects).

Method

Subjects:

Subjects in the present study are 83 children at Miyagi Prefectural Kōmyō School for mentally retarded children, comprising 27 children in the IQ–50 group, 25 in the IQ–60 group, and 31 in the IQ–70 group as shown in Table 1.

Experimental room:

The experimental room is schematically shown in Fig. 1, where the testing objects are placed at random on table A.

Table 1 Characteristics of the subjects

IQ Groups		50 group	60 group	70 group	Total group (50-70 group)
CA* (months)	Range	113-187	90-171	90-184	90-187
	Mean	158	143	146	149
MA** (months)	Range	58-102	60-111	70-138	58-138
	Mean	86	92	107	96
IQ**	Range	51-60	61-70	71-80	51-80
	Mean	56.3	65.7	75.2	66.2
Sex	Male	13	14	17	44
	Female	14	11	14	39
N		27	25	31	83

* CA is made up as of the date when Experiment I was carried out.

** In accordance with the Suzuki-Binet Intelligence Scale, MA and IQ determined within three months from the day when Experiment I was performed.

[2]The definition of "verbal memory span" and "performance memory span" used in the present paper is as follows:

Verbal memory span: To be determined by the score which was correctly repeated in word by the subject recalling the testing material instructed.

Performance memory span: To be determined by the score which was correctly repeated in performance by the subject recalling the testing material instructed.

Schematic representation of experimental room

A.....Round table
B.....Rectangular table
C.....Experimenter's table position
D.....Screen
E.....Position where the subject is instructed

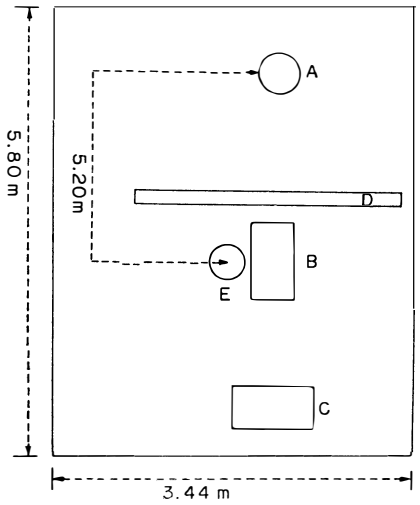

Fig. 1

Procedure:

(1) *VMS on numbers*: Numerical repetition tasks were assigned in accordance with the manual of WISC (Japanese edition, Kodama & Shinagawa, 1965). Of the numerical series shown in Table 2, the greatest number which was correctly repeated in one of the series is regarded as VMS on numbers for each subject.

Table 2 Testing material for VMS (Numbers) (from WISC)

Ordered repetitions	
The first series	The second series
(1) 3-8-6	(1) 6-1-2
(2) 3-4-1-7	(2) 6-1-5-8
(3) 8-4-2-3-9	(3) 5-2-1-8-6
(4) 3-8-9-1-7-4	(4) 7-9-6-4-8-3
(5) 5-1-7-4-2-3-8	(5) 9-8-5-2-1-6-3
(6) 1-6-4-5-9-7-6-3	(6) 2-9-7-6-3-1-5-4
(7) 5-3-8-7-1-2-4-6-9	(7) 4-2-6-9-1-7-8-3-5
Reverse repetitions	
The first series	The second series
(1) 2-5	(1) 6-3
(2) 5-7-4	(2) 2-5-9
(3) 7-2-9-6	(3) 8-4-9-3
(4) 4-1-3-5-7	(4) 9-7-8-5-2
(5) 1-6-5-2-9-8	(5) 3-6-7-1-9-4
(6) 8-5-9-2-3-4-2	(6) 4-5-7-9-2-8-1
(7) 6-9-1-6-3-2-5-8	(7) 3-1-7-9-5-4-8-2

(2) *PMS on specific objects*: After listening to the names of objects as rice-bowl (*chawan*) or chopsticks (*hashi*), at the position E of Fig. 1 with the interval of about one second, the subject was instructed to bring the named objects one by one from table A to table B. As indicated in Table 3, the testing objects used were 10 articles which were selected from among those familiar in daily life to the subjects and placed at random after assorting them in numbers of 1–10 respectively[3], in two series. Of the two series assorted, the greatest number of the objects which were correctly placed on table A is regarded as PMS on specific objects for each subject.

Table 3 Testing material for PMS (Specific objects)

The first series	The second series
(1) book	(1) pencil
(2) scissors, handkerchief	(2) tissue, crayon
(3) pencase, pad, note-book	(3) eraser, scissors, book
(4) crayon, eraser, tissue, pencil	(4) handkerchief, pencase, note-book, pad
(5) pad, book, handkerchief, pencase, scissors	(5) scissors, pencil, eraser, tissue, crayon
(6) note-book, tissue, eraser, crayon, pad, pencil	(6) book, scissors, note-book, pencase, handkerchief, pad
(7) handkerchief, note-book, pencase, book, scissors, tissue, eraser	(7) eraser, book, tissue, crayon, pencil, scissors, note-book
(8) pencil, pad, book, handkerchief, note-book, pencase, crayon, scissors	(8) crayon, pencase, eraser, pad, handkerchief, book, tissue, pencil
(9) pencase, handkerchief, crayon, note-book, eraser pad, tissue, pencil, book	(9) pad, crayon, tissue, scissors, handkerchief, pencase, note-book, book, eraser
(10) pad, scissors, pencase, handkerchief, pencil, crayon, book, eraser, note-book, tissue	(10) pencil, tissue, eraser, crayon, handkerchief, note-book, pad, book, pencase, scissors

Results

I. VMS and PMS in STM

(1) *VMS on numbers*: Table 4 shows VMS on numbers, that is, spans, mean values and SD of ordered repetitions, reverse repetitions and scores (the score is counted by the number of correct answers in ordered repetition and reverse repetition in accordance with the manual of WISC), for each IQ group and the total group. In Table 5 is shown the difference in mean values of ordered repetitions, reverse repetitions and scores.

[3]This is based on the pre-test.

Table 4 VMS on numbers

IQ Groups		Ordered repetition	Reverse repetition	Score
50-group	Span	0-5	0-4	0-8
	Mean	3.1	1.7	4.9
	SD	1.26	1.32	2.29
60-group	Span	3-5	0-4	3-8
	Mean	3.7	2.2	6.0
	SD	.72	1.14	1.61
70-group	Span	3-6	0-5	3-10
	Mean	3.9	3.1	7.0
	SD	.88	1.14	1.81
Total group (50–70 group)	Span	0-6	0-5	0-10
	Mean	3.6	2.4	6.0
	SD	1.04	1.33	2.13

Table 5 Difference in mean values of ordered repetitions, reverse repetitions and scores for each IQ group

	Ordered repetition		Reverse repetition		Score	
IQ Groups	50-group	60-group	50-group	60-group	50-group	60-group
60-group	.6**	..	.5	..	1.1	..
70-group	.8**	.2	1.4***	.9**	2.1***	1.0*

* Significant at .05 level of confidence.
** Significant at .01 level of confidence.
*** Significant at .001 level of confidence.

(2) *PMS on specific objects*: The result of PMS on specific objects obtained for each IQ group is indicated in Table 6, while the difference in mean values of PMS on specific objects for each IQ group is shown in Table 7.

Table 6 PMS on specific objects

IQ Groups		PMS on specific objects
50-group	Span	1-4
	Mean	2.8
	SD	.72
60-group	Span	2-4
	Mean	3.2
	SD	.62
70-group	Span	3-5
	Mean	3.5
	SD	.56
Total group (50-70 group)	Span	1-5
	Mean	3.2
	SD	.70

Table 7 Difference in mean values of PMS on specific objects for each IQ group

IQ Groups	PMS on specific objects	
	50-group	60-group
60-group	.4*	..
70-group	.7***	.3

* Significant at .05 level of confidence.
*** Significant at .001 level of confidence.

II. Relationship between VMS and PMS in STM

The relationship between VMS on numbers and PMS on specific objects is represented in Table 8.

Table 8 Relationship between VMS on numbers and PMS on specific objects

VMS on numbers	PMS on specific objects
Ordered repetition	.59***
Reverse repetition	.52***
Score	.61***

*** Significant at .001 level of confidence.

Experiment II

In Experiment I the testing on VMS (testing material; numbers) and PMS (testing material; specific objects) was performed using different materials. In Experiment II it was intended to use the same materials for the testing of VMS and PMS. For this purpose, the validity of the following hypotheses was examined.

Hypothesis III.

(1) VMS (testing material; specific objects) and PMS (testing material; specific objects) in STM of the retardates in the IQ–50 group are inferior to those in the IQ–70 group.

(2) VMS (testing material; numbers) and PMS (testing material; numbers) in STM of the retardates in the IQ–50 group are inferior to those in the IQ–70 group.

Hypothesis IV.

(1) Among the retardates in the three groups of IQ–50, IQ–60 and IQ–70, there are correlations between VMS (testing material; specific objects) and PMS (testing material; specific objects).

(2) Among the retardates grouped into IQ–50, IQ–60 and IQ–70, there are correlations between VMS (testing material; numbers) and PMS (testing material; numbers).

Method

Subjects:

Subjects tested are the same as those in Experiment I.

Experimental room:

The experimental room used is entirely the same as described in Experiment I. For the testing of PMS, building blocks were placed at random on table A.

Procedure:

(1) *VMS on objects*: Immediately after being told the names of specific objects, such as rice-bowl (*chawan*) or chopsticks (*hashi*), word by word at the position E with the interval of about one second, the subject was instructed to repeat verbally. The greatest number of the words which were correctly repeated in one of the two series is regarded as VMS on objects for each subject. As the testing material, the objects shown in Table 3 were used as words.

(2) *PMS on objects*: The testing was not carried out, because the result of Experiment I (2) was used.

(3) *VMS on numbers*: Immediately after being told numbers, such as 2 (two), 2(two), one by one at the position E with the interval of about one second, the subject was instructed to repeat verbally the numbers. The greatest number which was correctly repeated in one of the two series is regarded as VMS on numbers for each subject. As the testing material, the numbers which were assorted with 1 and 2 at random in two series were used (Table 9).

(4) *PMS on numbers*: After listining to the numbers, for example, 2(two), 2 (two), one by one at the position E with the interval of about one second, the subject was instructed to take two building blocks on table A and then two more to table B. The greatest number of building blocks in the two series which were correctly brought over to table B is regarded as PMS on numbers for each subject. As the testing material, uncolored building blocks of 6.5×6.5×3 cm were assorted to represent the numbers shown in Table 9.

Table 9 Testing material for VMS and PMS (Numbers)

The first series	The second series
(1) 2	(1) 1
(2) 2 1	(2) 1 2
(3) 1 2 1	(3) 2 1 1
(4) 2 1 1 2	(4) 1 2 2 1
(5) 1 2 1 1 2	(5) 2 1 2 1 1
(6) 1 1 2 1 2 2	(6) 2 1 1 2 1 2
(7) 2 1 2 1 1 1 2	(7) 1 2 1 2 1 1 2
(8) 2 1 1 2 2 1 2 1	(8) 1 2 1 1 2 2 1 2
(9) 1 2 1 2 2 1 2 1 1	(9) 2 1 1 2 1 2 1 1 2

Results

I. VMS and PMS in STM

Table 10 shows the results of VMS and PMS on numbers and specific objects, while

the difference in mean values of VMS and PMS on numbers and specific objects in each IQ group is shown in Table 11. In Table 12 are indicated the difference in mean values of VMS and PMS on specific objects and the difference in mean values of VMS and PMS on numbers in the same IQ groups.

Table 10 VMS and PMS on specific objects, VMS and PMS on numbers

IQ Groups		Specific objects		Numbers	
		VMS	PMS	VMS	PMS
50-group	Span	1-4	1-4	1-7	1-6
	Mean	3.0	2.8	3.6	3.1
	SD	.51	.72	1.26	1.21
60-group	Span	2-4	2-4	3-5	1-6
	Mean	3.3	3.2	4.1	3.8
	SD	.53	.62	.66	1.05
70-group	Span	3-5	3-5	3-5	3-6
	Mean	3.5	3.5	4.5	4.4
	SD	.24	.56	.71	.83
Total group (50-70 group)	Span	1-5	1-5	1-7	1-6
	Mean	3.3	3.2	4.1	3.8
	SD	.57	.70	1.00	1.15

Table 11 The difference in mean values of VMS and PMS on numbers and specific objects in each IQ group

IQ groups	VMS		PMS		VMS		PMS	
	50 group	60 group	50 group	60 group	50 group	60 group	50 group	60 group
60-group	.3*	..	.4*	..	.5	..	.7*	..
70-group	.5***	.2	.7***	.3	.9**	.4*	1.3***	.6*

* Significant at .05 level of confidence.
** Significant at .01 level of confidence.
*** Significant at .001 level of confidence.

Table 12 The difference in mean values of VMS and PMS on specific objects and the difference in mean values of VMS and PMS on numbers in each IQ group

	Specific objects	Numbers
IQ Groups	VMS—PMS	VMS—PMS
50-group	.2	.5
60-group	.1	.3
70-group	0	.1
Total group (50-70 group)	.1	.3**

** Significant at .01 level of confidence.

II. Relationship between VMS and PMS in STM

(1) Correlations between VMS and PMS on specific objects and VMS and PMS on numbers are shown in Table 13.

Table 13 Correlations between VMS and PMS on specific objects and VMS and PMS on numbers

	Specific objects		Numbers
	VMS	PMS	VMS
PMS (specific objects)	.47***	..	..
VMS (numbers)	.42***	.54***	..
PMS (numbers)	.36***	.46***	.67***

*** Significant at .001 level of confidence.

(2) Correlations between VMS and PMS on specific objects and VMS and PMS on numbers in each IQ-group are shown in Table 14.

Table 14 Correlations between VMS and PMS on specific objects and VMS and PMS on numbers in each IQ group

IQ Groups	VMS-PMS	VMS-PMS
50 group	.42*	.20
60 group	.48*	.32
70 group	.36*	.71***
Total group (50-70 group)	.47***	.67***

* Significant at .05 level of confidence.
*** Significant at .001 level of confidence.

Discussion

The results of Experiment I indicate that VMS (ordered repetition, reverse repetition, score, testing material; numbers) and PMS (testing material; specific objects) of the retardates in the IQ–50 group are inferior to those in the IQ–70 group, thus sustaining hypothesis I. According to the results of experiments on VMS on numbers and PMS on specific objects for the IQ–40 group (N=7) and the IQ–80 group (N=9), the mean values of memory span were 2.9 in ordered repetition, 1.1 in reverse repetition, 4.0 in score and 2.3 in PMS on specific objects for the former group and 4.7 in repetition, 3.2 in reverse repetition, 7.6 in score and 4.1 in PMS on specific objects for the latter. In other words, the mean values of memory span in the IQ–40 showed a tendency to be lower than those of the IQ–50 group, and those in the IQ–80 group tended to be higher than in the IQ–70 group. Since these results were obtained with a small number of subjects, it is more desirable that experiments be carried out with a larger number of subjects including those other than the IQ groups indicated in Experiment I. VMS (testing material; numbers) and PMS (testing material; specific objects) in the groups of IQ–50,

IQ–60 and IQ–70 showed a considerable correlation, which sustains the validity of hypothesis II.

The results of Experiment II indicate that VMS (testing material; numbers and specific objects) and VMS (testing material; numbers and specific objects) in STM of the retardates in the IQ–50 group are inferior to those in the IQ–70 group, thus supporting the validity of hypothesis III. Next, VMS (testing material; numbers and specific objects) and PMS (testing material; numbers and specific objects) of the retardates in the IQ–50, IQ–60 and IQ–70 groups show the existence of a considerable correlation, by which hypothesis IV is maintained. Also, as shown in Table 13, it is known that there is a correlation among the other values of memory span.

Ellis (1963) stated that when the same stimulus is given to two organisms, normal and subnormal, the duration of the stimulus control would be longer in the former than in the latter. However, the results of the present study which validated hypotheses I and III seem to suggest that in the so-called educable mentally retarded children the duration of the stimulus control is longer in the high IQ group (IQ–70) than that in the low IQ group (IQ–50). Moreover, the fact that hypotheses II and IV were validated by the present study may indicate that VMS (testing material; specific objects) and PMS (specific objects), and VMS (testing material; numbers) and PMS (numbers) would serve as predicators for one another.

Of late, the author and co-worker (Kataoka & Sato, 1967) have reported their experiments relating to a programmed instruction, and emphasized the necessity of taking memory span of subjects into consideration. The present author is convinced that a knowledge of VMS and PMS obtained by such an experiment as mentioned above will greatly contribute to the development of instruction techniques for mentally retarded children.

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Zusammenfassung

Es wurden durch Versuche die folgenden Hypothesen auf die Richtigkeit geprüft: die wörtliche Gedächtnisspanne und die Leistungsgedachtnisspanne der retardierten Schüler von IQ (Intelligensquotient) 50 sind minderwertiger als diejenigen der Schüler von IQ 70, und unter den Versuchspersonen von IQ 50, 60 und 70 befinden sich die Korrelationen beziehungen für diese zwei Arten Gedächtnis.

Als Versuchspersonen dienten 83 Kinder 27 in der IQ 50 Gruppe, 25 in der IQ 60 Gruppe, und 31 in der 70 Gruppe. Als Versuchs materialien wurden Zahlen, gemeine Dinge und Banklötze gebraucht.

Aus den Versuchsergebnissen folgt, dass unsere Hypothesen richitig sind.